JC19 Rec'd PCT/PTO 21 MAY 2001

FORM PTO-1390 (REV. 10-2000) U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE		ATTORNEY'S DOCKET NUMBER S1022/8668
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		U S APPLICATION NO (If known, see 37 CFR 1 5) 09/856438
INTERNATIONAL APPLICATION NO. PCT/SE99/02116	INTERNATIONAL FILING DATE 18 November 1999	PRIORITY DATE CLAIMED 21 November 1998 5 March 1999

TITLE OF INVENTION
IMPROVEMENTS IN, OR RELATING TO, VDSL TRANSMISSION SYSTEMS

APPLICANT(S) FOR DO/EO/US SJÖBERG, Franck, WILSON, Sarah Kate, NILSSON, Rikard, BENGTSSON, Daniel, ISAKSSON, Mikael, NORDSTROM, Tomas, ÖDLING, Per, BAHLENBERG, Gunnar, JOHANSSON, Magnus, OLSSON Lennart, OKVIST, Sven-Göran

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This is an express request to promptly begin national examination procedures (35 U.S.C. 371(f)).
4. ☐ The US has been elected by the expiration of 19 months from the earliest claimed priority date (PCT Article31).
5. ☐ A copy of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ has been transmitted by the International Bureau.
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)).
   a. ☐ are attached hereto (required only if not transmitted by the International Bureau).
   b. ☐ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(C)(5))

Items 11. To 16. Below concern document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included
13. ☒ A FIRST preliminary amendment.
14. ☐ A SECOND or SUBSEQUENT preliminary amendment.
15. ☐ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C.1.821-1.825.
18. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. ☒ Other items or information: Title page of WO 00/31890

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U.S. APPLICATION NO. (If known, see 37 C.F.R. 1.5) 09/856438	INTERNATIONAL APPLICATION PCT/SE99/02116	ATTORNEY'S DOCKET NUMBER S1022/8668

21. ☒ The following fees are submitted:

BASIC NATIONAL FEE (37 CFR 1.492(a)(1)-(5)): — CALCULATIONS / PTO USE ONLY

Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO	$1000.00
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO	$860.00
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but but international search fee paid to USPTO (37 CFR 1.445(a)(2)).paid to USPTO	$710.00
International preliminary examination fee paid to USPTO (37 CFR 1.482) But all claims did not satisfy provisions of PCT Article 33(1)-(4)	$690.00
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4)	$100.00

ENTER APPROPRIATE BASIC FEE AMOUNT = $860.00

				CALCULATIONS	PTO USE ONLY
Surcharge of $130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).				$	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total Claims	23 - 20 =	3	X $18.00	$ 54.00	
Independent Claims	3 - 3 =		X $80.00	$	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+$270.00	$	
PETITION TO REVIVE FEE				$	
TOTAL OF ABOVE CALCULATIONS =				$ 914.00	
☐ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by ½.				$	
SUBTOTAL =				$	
Processing fee of $130.00 for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				$	
TOTAL NATIONAL FEE =				$ 914.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate coversheet (37 CFR 3.28, 3.31). $40.00 per property +				$ 40.00	
TOTAL FEES ENCLOSED =				$ 954.00	
				Amount to be: refunded	$
				charged	$

a. ☒ A check in the amount of $954.00 to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. ____________ In the amount of $____________ To cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 23/2825 A duplicate of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO

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09/856438

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: SJÖBERG, Franck, WILSON, Sarah Kate, NILSSON, Rikard, BENGTSSON, Daniel, ISAKSSON, Mikael, NORDSTROM, Tomas, ÖDLING, Per, BAHLENBERG, Gunnar, JOHANSSON, Magnus, OLSSON Lennart, OKVIST, Sven-Göran
Serial No.: Unassigned
Filing Date: Herewith
For: IMPROVEMENTS IN, OR RELATING TO, VDSL TRANSMISSION SYSTEMS

Examiner: Unassigned
Art Unit: Unassigned

Commissioner for Patents
Box Patent Application (DO/EO/US)
Washington, D.C. 20231

PRELIMINARY AMENDMENT

Sir/Madam:

Prior to examination, please amend the above-identified application as follows:

IN THE SPECIFICATION

On page 1, after the title, insert and center--Background of the Invention--;

On page 1, before line 2, insert --1. Field of the Invention--;

On page 1, before line 6, insert --2. Discussion of the Related Art--;

On page 1, before line 12, insert --Summary Of The Invention--;

On page 6, before line 3, insert --Brief Description Of The Drawings--;

On page 6, before line 6, insert –Detailed Description--;

On page 8, after line 10, insert the following paragraphs:

-- Having thus described at least one illustrative embodiment of the invention, various alterations, modifications, and improvements will readily occur to those skilled in the art. Such alterations, modifications, and improvements are intended to be within the spirit and scope of the invention. Accordingly, the foregoing description is by way of example only and is not intended as limiting. The invention is limited only as defined in the following claims and the equivalents thereto.

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What is claimed is:--;

IN THE CLAIMS

1. (Amended) A very high rate digital subscriber line transmission system having a plurality of modems operating on an access network in which at least some of said modems operate on wires of different lengths and in which there is a target bit rate for each modem, wherein modems on relatively short wires have control means for reducing their transmit power so that far end cross talk produced by said modems is reduced enabling modems on substantially longer wires to transmit at higher bit rates.

2. (Amended) A very high rate digital subscriber line system, as claimed in claim 1, wherein said relatively short wires are less than 1,000 metres long and said substantially longer wires are more than 1,000 metres long.

3. (Amended) A very high rate digital subscriber line system, as claimed in claim 1 wherein said control means are adapted to distribute power over an available frequency band so that said target bit rate is achieved.

4. (Amended) A very high rate digital subscriber line system, as claimed in claim 1 wherein said system is adapted to modulate transmitted data using discrete multitone.

5. (Amended) A very high rate digital subscriber line system, as claimed in claim 1, wherein the control means, associated with a given modem connected to a given wire, is adapted to produce an energy loading for the k^{th} sub-carrier given by:

$$E_k = \lambda \frac{n_k}{F_k}$$

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where n_k is the background noise on sub-carrier k, F_k is the [far end cross talk transfer function for said given wire and λ is a constant, λ being adjusted so that

$$R = \sum_{k-0}^{N-1} \log_2(1 + \frac{E_k}{\Gamma(n_k + Fext_k)\Gamma_M})$$

where $Fext_k$ is a far end cross talk from other very high rate digital subscriber line modems, Γ is a signal to noise ratio-gap, Γ_m is a system margin and R is a target bit rate per discrete multitone frame.

6. (Amended) A very high rate digital subscriber line system, as claimed in 5, wherein said far end cross talk transfer function is given by:

$$F_k - K \backslash H_k \backslash^2 \int_k^2 d$$

where H_k is a transfer function for a given wire, f_k is a frequency for subcarrier k, d is the length of wire and K is a constant.

7. (Amended) A very high rate digital subscriber line system, as claimed in claim 5, wherein E_k is always less than a maximal allowable power spectral density-level, PSD_{max} for said very high rate digital subscriber line system.

8. (Amended) A very high rate digital subscriber line system, as claimed in claim 7, wherein:

$$E_k = \lambda \frac{n_k}{F_k} \quad \text{for} \quad \lambda \frac{n_k}{F_k} < PSD_{max}$$

and

$$E_k - PSD_{max} \quad \text{for} \quad \lambda \frac{n_k}{F_k} \geq PSD_{max}$$

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9. (Amended) A modem for use with a very high rate digital subscriber line transmission system having a plurality of modems operating on an access network in which at least some of said modems operate on wires of different lengths, said modem having a target bit ratewherein said modem has control means for reducing its transmit power so that far end cross talk produced by said modem is reduced.

10. (Amended) A modem, as claimed in claim 9, wherein said control means is adapted to distribute power over an available frequency band so that said target bit rate is achieved.

11. (Amended) A modem, as claimed in claim 9, wherein said modem is adapted to modulate transmitted data using discrete multitone.

12. (Amended) A modem, as claimed in claim 9 wherein said modem is connected to a wire, and in that said control means is adapted to produce an energy loading for the k^{th} sub-carrier given by:

$$E_k = \lambda \frac{n_k}{F_k}$$

where n_k is [the] a background noise on sub-carrier k, F_k is a far end cross talk transfer function for said wire and λ is a constant, λ being adjusted so that

$$R = \sum_{k+0}^{N-1} \log_2 (1 + \frac{E_k}{\Gamma(n_k \_ + Fext_k)\Gamma_M})$$

where $Fext_k$ is a far end cross talk from other very high rate digital subscriber line modems, Γ is a signal to noise ratio-gap, Γ_m is a system margin and R is a target bit rate per discrete multitone frame.

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13. (Amended) A modem, as claimed in claim 12, wherein said far end cross talk transfer function is given by:

$$F_k - K \setminus H_k \setminus^2 \int_k^2 d$$

where H_k is a transfer function for the given wire, f_k is a frequency for subcarrier k, d is a length of the wire and K is a constant.

14. (Amended) A modem, as claimed in claim 12, wherein E_k is always less than a maximal allowable power spectral density-level for very high rate digital subscriber line.

15. (Amended) A modem, as claimed in claim 14, wherein:

$$E_k = \lambda \frac{n_k}{F_k} \quad \text{for} \quad \lambda \frac{n_k}{F_k} < PSD_{\max}$$

and

$$E_k - PSD_{\max} \quad \text{for} \quad \lambda \frac{n_k}{F_k} \geq PSD_{\max}$$

16. (Amended) In a very high rate digital subscriber line transmission system having a plurality of modems operating on an access network in which at least some of said modems operate on wires of different lengths and in which there is a target bit rate for each modem, a method of performing power back-off, including reducing the transmit power of modems on relatively short wires so that far end cross talk produced by said modems is reduced enabling modems on substantially longer wires to transmit at higher bit rates.

17. (Amended) A method as claimed in claim 16, including said relatively short wires being less than 1,000 metres long, and by said substantially longer wires being more than 1,000 metres long.

18. (Amended) A method as claimed in claim 16, including distributing power over an available frequency band so that said target bit rate is achieved.

19. (Amended) A method, as claimed in claim 16, including modulating transmitted data using discrete multitone.

20. (Amended) A method as claimed in claim 15, whereby producing an energy loading for the k^{th} sub-carrier given by:

$$E_k = \lambda \frac{n_k}{F_k}$$

where n_k is the background noise on sub-carrier k, F_k is the far end cross talk transfer function for said given wire and λ is a constant, λ being adjusted so that

$$R = \sum_{k+0}^{N-1} \log_2 (1 + \frac{E_k}{\Gamma(n_k \_ + Fext_k)\Gamma_M})$$

where $Fext_k$ is a far end cross talk from other very high rate digital subscriber line modems, Γ is a signal to noise ratio -gap, Γ_m is a system margin and R is a target bit rate per discrete multitone frame.

21. (Amended) A method, as claimed in claim 20, wherein said far end cross talk transfer function being given by:

$$F_k - K \backslash H_k \backslash^2 \int_k^2 d$$

where H_k is a transfer function for the given wire, f_k is a frequency for sub-carrier k, d is a length of the wire and K is a constant.

22. (Amended) A method, as claimed in either claim 20, or 21, wherein E_k always less than a maximal allowable power spectral density-level, PSD_{max} for said very high rate digital subscriber line system.

23. (Amended) A method, as claimed in claim 22, wherein:

$$E_k = \lambda \frac{n_k}{F_k} \quad \text{for} \quad \lambda \frac{n_k}{F_k} < PSD_{\max}$$

and

$$E_k - PSD_{\max} \quad \text{for} \quad \lambda \frac{n_k}{F_k} \geq PSD_{\max}$$

REMARKS

This is a preliminary amendment in which the claims have been amended to place them in better form before initial examination by the Examiner. Favorable action is hereby earnestly solicited.

Respectfully submitted,

By: ____________________
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AMENDED CLAIMS SHOWING THE AMENDMENTS

1. (Amended) A [VDSL] very high rate digital subscriber line transmission system having a plurality of modems operating on an access network in which at least some of said modems operate on wires of different lengths and in which there is a target bit rate for each modem, [characterised in that] wherein modems on relatively short wires have control means for reducing their transmit power so that [FEXT] far end cross talk produced by said modems is reduced enabling modems on substantially longer wires to transmit at higher bit rates.

2. (Amended) A [VDSL] very high rate digital subscriber line system, as claimed in claim 1, [characterised in that] wherein said relatively short wires are less than 1,000 metres long and said substantially longer wires are more than 1,000 metres long.

3. (Amended) A [VDSL] very high rate digital subscriber line system, as claimed in claim 1[, or claim 2, characterised in that] wherein said control means are adapted to distribute power over an available frequency band so that said target bit rate is achieved.

4. (Amended) A [VDSL] very high rate digital subscriber line system, as claimed in claim 1 [any previous claim, characterised in that] wherein said system is adapted to modulate transmitted data using [DMT] discrete multitone.

5. (Amended) A [VDSL] very high rate digital subscriber line system, as claimed in [any previous claim] claim 1, [characterised in that] wherein the control means, associated with a given modem connected to a given wire, is adapted to produce an energy loading for the k^{th} sub-carrier given by:

$$E_k = \lambda \frac{n_k}{F_k}$$

where n_k is the background noise on sub-carrier k, F_k is the [FEXT] far end cross talk transfer function for said given wire and λ is a constant, λ being adjusted so that

$$R = \sum_{k-0}^{N-1} \log_2 (1 + \frac{E_k}{\Gamma(n_k + Fext_k)\Gamma_M})$$

where $Fext_k$ is [the FEXT] a far end cross talk from other [VDSL] very high rate digital subscriber line modems, Γ is [the] a [SNR] signal to noise ratio-gap, Γ_m is [the] a system margin and R is [the] a target bit rate per [DMT] discrete multitone frame.

6. (Amended) A [VDSL] very high rate digital subscriber line system, as claimed in 5, [characterised in that] wherein said [FEXT] far end cross talk transfer function is given by:

$$F_k - K \backslash H_k \backslash^2 \int_k^2 d$$

where H_k is [the] a transfer function for [the] a given wire, f_k is [the] a frequency for subcarrier k, d is the length of wire and K is a constant.

7. (Amended) A [VDSL] very high rate digital subscriber line system, as claimed in [either] claim 5, [or 6, characterised in that] wherein E_k is always less than a maximal allowable [PSD] power spectral density-level, PSD_{max} for said [VDSL] very high rate digital subscriber line system.

8. (Amended) A [VDSL] very high rate digital subscriber line system, as claimed in claim 7, [characterised in that] wherein: $E_k = \lambda \frac{n_k}{F_k}$ for $\lambda \frac{n_k}{F_k} < PSD_{max}$

and

$$E_k - PSD_{\max} \quad \text{for} \quad \lambda \frac{n_k}{F_k} \geq PSD_{\max}$$

9. (Amended) A modem for use with a [VDSL] very high rate digital subscriber line transmission system having a plurality of modems operating on an access network in which at least some of said modems operate on wires of different lengths, said modem having a target bit rate, [characterised in that] wherein said modem has control means for reducing its transmit power so that [FEXT] far end cross talk produced by said modem is reduced.

10. (Amended) A modem, as claimed in claim 9, [characterised in that] wherein said control means is adapted to distribute power over an available frequency band so that said target bit rate is achieved.

11. (Amended) A modem, as claimed in [either] claim 9, [or 10, characterised in that] wherein said modem is adapted to modulate transmitted data using [DMT] discrete multitone.

12. (Amended) A modem, as claimed in claim 9 [any of claims 9 to 11, characterised in that] wherein said modem is connected to a wire, and in that said control means is adapted to produce an energy loading for the k^{th} sub-carrier given by:

$$E_k = \lambda \frac{n_k}{F_k}$$

where n_k is [the] a background noise on sub-carrier k, F_k is [the FEXT] a far end cross talk transfer function for said wire and λ is a constant, λ being adjusted so that

$$R = \sum_{k+0}^{N-1} \log_2 \left(1 + \frac{E_k}{\Gamma(n_k \_ + Fext_k)\Gamma_M}\right)$$

where $Fext_k$ is [the FEXT] a far end cross talk from other [VDSL] very high rate digital subscriber line modems, Γ is [the] a [SNR] signal to noise ratio-gap, Γ_m is [the] a system margin and R is [the] a target bit rate per [DMT] discrete multitone frame.

13. (Amended) A modem, as claimed in claim 12, [characterised in that] wherein said [FEXT] far end cross talk transfer function is given by:

$$F_k - K \backslash H_k \backslash^2 \int_k^2 d$$

where H_k is [the] a transfer function for the given wire, f_k is [the] a frequency for subcarrier k, d is [the] a length of the wire and K is a constant.

14. (Amended) A modem, as claimed in [either] claim 12, [or 13, characterised in that] wherein E_k is always less than a maximal allowable [PSD] power spectral density-level for [VDSL] very high rate digital subscriber line.

15. (Amended) A modem, as claimed in claim 14, [characterised in that] wherein:

$$E_k = \lambda \frac{n_k}{F_k} \quad \text{for} \quad \lambda \frac{n_k}{F_k} < PSD_{\max}$$

and

$$E_k - PSD_{\max} \quad \text{for} \quad \lambda \frac{n_k}{F_k} \geq PSD_{\max}$$

16. (Amended) In a [VDSL] very high rate digital subscriber line transmission system having a plurality of modems operating on an access network in which at least some of said modems operate on wires of different lengths and in which there is a target bit rate for each modem, a method of performing power back-off, [characterised by] including reducing the transmit power of modems on relatively short wires so that [FEXT] far end cross talk

produced by said modems is reduced enabling modems on substantially longer wires to transmit at higher bit rates.

17. (Amended) A method as claimed in claim [15] 16, [characterised by] including said relatively short wires being less than 1,000 metres long, and by said substantially longer wires being more than 1,000 metres long.

18. (Amended) A method as claimed in [either] claim 16, [or claim 17, characterised by] including distributing power over an available frequency band so that said target bit rate is achieved.

19. (Amended) A method, as claimed in [any of claims 16, to 18, characterised by] claim 16, including modulating transmitted data using [DMT] discrete multitone.

20. (Amended) A method as claimed in [any of claims 15 to 19, characterised by] claim 15, whereby producing an energy loading for the k[th] sub-carrier given by:

$$E_k = \lambda \frac{n_k}{F_k}$$

where n_k is the background noise on sub-carrier k, F_k is the [FEXT] far end cross talk transfer function for said given wire and λ is a constant, λ being adjusted so that

$$R = \sum_{k+0}^{N-1} \log_2 (1 + \frac{E_k}{\Gamma(n_k \_ + Fext_k)\Gamma_M})$$

where $Fext_k$ is [the FEXT] a far end cross talk from other [VDSL] very high rate digital subscriber line modems, Γ is [the] a [SNR] signal to noise ratio-gap, Γ_m is [the] a system margin and R is [the] a target bit rate per [DMT] discrete multitone frame.

21. (Amended) A method, as claimed in claim 20, [characterised by] wherein said [FEXT] far end cross talk transfer function being given by:

$$F_k - K \backslash H_k \backslash^2 \int_k^2 d$$

where H_k is [the] a transfer function for the given wire, f_k is [the] a frequency for sub-carrier k, d is [the] a length of the wire and K is a constant.

22. (Amended) A method, as claimed in either claim 20, or 21, [characterised by] wherein E_k always less than a maximal allowable [PSD] power spectral density-level, PSD_{max} for said [VDSL] very high rate digital subscriber line system.

23. (Amended) A method, as claimed in claim 22, [characterised by] wherein:

$$E_k = \lambda \frac{n_k}{F_k} \quad \text{for} \quad \lambda \frac{n_k}{F_k} < PSD_{max}$$

and

$$E_k - PSD_{max} \quad \text{for} \quad \lambda \frac{n_k}{F_k} \geq PSD_{max}$$

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Improvements in, or Relating to, VDSL Transmission Systems

The present invention relates to a VDSL transmission system in which power control is used to reduce FEXT, a modem for use in a VDSL transmission system, and a method of reducing FEXT in a VDSL transmission system by using power back-off.

One problem, frequently encountered with VDSL transmission systems, is that upstream FEXT produced by system users having short wires can be very strong. This severely limits the performance for users with longer wires. Users having shorter wires get high bit rates whereas users having longer wires get low bit rates, or possibly a zero bit rate. In extreme cases it may happen that users with wire lengths greater than 1000 metre cannot transmit data upstream.

The present invention provides a way of overcoming this problem by using power back-off to provide a more even distribution of the available bandwidth capacity among customers with different wire lengths. Power back-off means that modems on shorter wires reduce their transmit power in order to lower the FEXT they produce. This enables modems on longer wires to obtain an acceptable bit rate.

Known techniques for reducing FEXT cannot set target bit rates for the users and cannot provide any sort of optimisation of bit rate distribution between users. The present invention gives a better performance, i.e. higher bit rates, than known techniques for reducing FEXT, especially for thinner, i.e. more lossy, wires.

According to a first aspect of the present invention, there is provided a VDSL transmission system having a plurality of modems operating on an access network in which at least some of said modems operate on wires of different lengths and in which there is a target bit rate for each modem, characterised in that modems on relatively short wires have control means for reducing their transmit power so that FEXT produced by said modems is reduced enabling modems on substantially longer wires to transmit at higher bit rates.

Said relatively short wires may be less than 1,000 metres long and said substantially longer wires are more than 1,000 metres long.

At least some of said modems may have control means adapted to distribute power over an available frequency band so that said target bit rate is achieved.

Said VDSL system may be adapted to modulate transmitted data using DMT.

The control means, associated with a given modem connected to a given wire, may be adapted to produce an energy loading for the k^{th} sub-carrier given by:

$$E_k = \lambda \frac{n_k}{F_k}$$

where n_k is the background noise on sub-carrier k, F_k is the FEXT transfer function for said given wire and λ is a constant, λ being adjusted so that

$$R = \sum_{k=0}^{N-1} \log_2\left(1 + \frac{E_k}{\Gamma(n_k + Fext_k)\Gamma_M}\right)$$

where $Fext_k$ is the FEXT from other VDSL modems, Γ is the SNR - gap, Γ_m is the system margin and R is the target bit rate per DMT frame.

Said FEXT transfer function may be given by:

$$F_k = K|H_k|^2 f_k^2 d$$

where H_k is the transfer function for the given wire, f_k is the frequency for subcarrier k, d is the length of the wire and K is a constant.

E_k may always be less than a maximal allowable PSD-level, PSD_{max}, for said VDSL system.

E_k may be given by:

$$E_k=\lambda\frac{n_k}{F_k} \qquad for \quad \lambda\frac{n_k}{F_k}<PSD_{\max}$$

and

$$E_k=PSD_{\max} \qquad for \quad \lambda\frac{n_k}{F_k}\geq PSD_{\max}$$

According to a second aspect of the present invention, there is provided a modem for use with a VDSL transmission system having a plurality of modems operating on an access network in which at least some of said modems operate on wires of different lengths, said modem having a target bit rate, characterised in that said modem has control means for reducing its transmit power so that FEXT produced by said modem is reduced.

Said control means may be adapted to distribute power over an available frequency band so that said target bit rate is achieved.

Said modem may be adapted to modulate transmitted data using DMT.

Said modem may be connected to a wire, and said control means may be adapted to produce an energy loading for the k^{th} sub-carrier given by:

$$E_k=\lambda\frac{n_k}{F_k}$$

where n_k is the background noise on sub-carrier k, F_k is the FEXT transfer function for said wire and λ is a constant, λ being adjusted so that

$$R=\sum_{k=0}^{N-1}\log_2\left(1+\frac{E_k}{\Gamma(n_k+Fext_k)\Gamma_M}\right)$$

where $Fext_k$ is the FEXT from other VDSL modems, Γ is the SNR - gap, Γ_m is the system margin and R is the target bit rate per DMT frame.

Said FEXT transfer function may be given by:

$$F_k = K|H_k|^2 f_k^2 d$$

where H_k is the transfer function for the given wire, f_k is the frequency for subcarrier k, d is the length of the wire and K is a constant.

Ek may always be less than a maximal allowable PSD-level for VDSL.

Ek may be given by:

$$E_k = \lambda\frac{n_k}{F_k} \qquad for \quad \lambda\frac{n_k}{F_k} < PSD_{\max}$$

and

$$E_k = PSD_{\max} \qquad for \quad \lambda\frac{n_k}{F_k} \geq PSD_{\max}$$

According to a third aspect of the present invention, there is provided, in a VDSL transmission system having a plurality of modems operating on an access network in which at least some of said modems operate on wires of different lengths and in which there is a target bit rate for each modem, a method of performing power back-off, characterised by reducing the transmit power of modems on relatively short wires so that FEXT produced by said modems is reduced enabling modems on substantially longer wires to transmit at higher bit rates.

Said relatively short wires may be less than 1,000 metres long and said substantially longer wires may be more than 1,000 metres long.

Power may be distributed over an available frequency band so that said

target bit rate is achieved.

Transmitted data may be modulated using DMT.

An energy loading for the k[th] sub-carrier given by:

$$E_k = \lambda \frac{n_k}{F_k}$$

where n_k is the background noise on sub-carrier k, F_k is the FEXT transfer function for said given wire and λ is a constant which is adjusted so that

$$R = \sum_{k=0}^{N-1} \log_2\left(1 + \frac{E_k}{\Gamma(n_k + Fext_k)\Gamma_M}\right)$$

where $Fext_k$ is the FEXT from other VDSL modems, Γ is the SNR - gap, Γ_m is the system margin and R is the target bit rate per DMT frame, may be produced.

Said FEXT transfer function may be given by:

$$F_k = K|H_k|^2 f_k^2 d$$

where H_k is the transfer function for the given wire, f_k is the frequency for sub-carrier k, d is the length of the wire and K is a constant.

E_k may always be less than a maximal allowable PSD-level, PSD_{max}, for said VDSL system.

Ek may be given by:

$$E_k = \lambda \frac{n_k}{F_k} \qquad for \quad \lambda \frac{n_k}{F_k} < PSD_{\max}$$

and

$$E_k = PSD_{\max} \qquad for \quad \lambda \frac{n_k}{F_k} \geq PSD_{\max}$$

Embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 illustrates a telephone access network in which the present invention may be implemented.

Figure 2 illustrates the way in which PSD varies for different wire lengths.

A glossary of the abbreviations used in this patent specification is set out below to aid the reader:

DMT:	Discrete Multi Tone
FEXT:	Far-End Cross Talk
PSD:	Power Spectral Density
SNR:	Signal to Noise Ratio
VDSL:	Very high rate Digital Subscriber Line

A typical telephone access network, suitable for use with a VDSL transmission system is shown in Figure 1. It will be seen that network terminals, NT, are located at a variety of distances from the central station, typically between 300m and 1,500m. Because of the FEXT produced by network terminals located close to the central station, the more remote terminals, further than 1,000m from the central station, may have little useable bandwidth available to them, i.e. they will only be able to transmit data in the upstream direction at low bit rates.

The present invention provides a method of performing power back-off in a VDSL modem, which may be located in any of the network terminals shown in

Figure 1. Consider a VDSL modem operating in the access network of Figure 1, on a wire of a given length, where several other modems operate on wires of different lengths. Some of the wire lengths may be longer and others may be shorter and yet others of the same length. The modem has a target bit rate assigned to it and the power is distributed over the frequency band in such a manner that the target bit rate can be achieved. The power distribution is made in such a way that the bit rates of other modems, connected to the same access network, are maximised.

Consider, as an example, a VDSL system employing DMT and let E_k denote the transmit energy to be used on sub-carrier k. If a target bit rate of R bits per DMT frame is to be achieved, the following constraint on the energies E_k exist:

$$R=\sum_{k=0}^{N-1}\log_2\left(1+\frac{E_k}{\Gamma(n_k+Fext_k)\Gamma_M}\right) \qquad (1)$$

where n_k is the background noise on sub-carrier k, $Fext_k$ is the FEXT from other VDSL modems, Γ is the SNR - gap (=9.8dB), Γ_m is the system margin (typically 3 - 6dB). To maximise the bit rate for the other VDSL modems, the energy on the k^{th} sub-carrier should be:

$$E_k=\lambda\frac{n_k}{F_k} \qquad (2)$$

where λ is a constant that is adjusted so that equation (1) is fulfilled, and F_k is the FEXT transfer function for the wire under consideration. The FEXT transfer function can be calculated from:

$$F_k=K|H_k|^2 f_k^2 d \qquad (3)$$

where H_k is the transfer function for the given wire, f_k is the frequency for subcarrier k, d is the length of the wire and K is a constant. K and d are of no great importance since they are subsumed in λ. By using equation (2) to set the energy distribution, the FEXT will be spectrally shaped in the same way as the background noise.

Another constraint, that must always be applied, is that E_k must never exceed the maximum allowable PSD-level for VDSL, i.e. PSD_{max}. This means that equation (2) can be rewritten as:

$$E_k=\lambda\frac{n_k}{F_k} \qquad for \quad \lambda\frac{n_k}{F_k}<PSD_{\max}$$

$$E_k=PSD_{\max} \qquad for \quad \lambda\frac{n_k}{F_k}\geq PSD_{\max}$$

If too large a value of R is chosen, then it may happen that $E_k = PSD_{max}$ for all k without achieving the target bit rate.

Figure 2 shows an example of how the PSD looks for different wire lengths. Shorter wires use lower transmit powers and tend to load more power on the higher frequencies than on the lower frequencies. Since the longer wires can only use the lower frequencies, it seems intuitive to let the short wires use the higher frequencies and save the lower frequencies for the longer wires.

CLAIMS

1. A VDSL transmission system having a plurality of modems operating on an access network in which at least some of said modems operate on wires of different lengths and in which there is a target bit rate for each modem, characterised in that modems on relatively short wires have control means for reducing their transmit power so that FEXT produced by said modems is reduced enabling modems on substantially longer wires to transmit at higher bit rates.

2. A VDSL system, as claimed in claim 1, characterised in that said relatively short wires are less than 1,000 metres long and said substantially longer wires are more than 1,000 metres long.

3. A VDSL system, as claimed in claim 1, or claim 2, characterised in that said control means are adapted to distribute power over an available frequency band so that said target bit rate is achieved.

4. A VDSL system, as claimed in any previous claim, characterised in that said system is adapted to modulate transmitted data using DMT.

5. A VDSL system, as claimed in any previous claim characterised in that the control means, associated with a given modem connected to a given wire, is adapted to produce an energy loading for the k^{th} sub-carrier given by:

$$E_k = \lambda \frac{n_k}{F_k}$$

where n_k is the background noise on sub-carrier k, F_k is the FEXT transfer function for said given wire and λ is a constant, λ being adjusted so that

$$R = \sum_{k=0}^{N-1} \log_2(1 + \frac{E_k}{\Gamma(n_k + Fext_k)\Gamma_M})$$

where $Fext_k$ is the FEXT from other VDSL modems, Γ is the SNR - gap, Γ_m is the

system margin and R is the target bit rate per DMT frame.

6. A VDSL system, as claimed in claim 5, characterised in that said FEXT transfer function is given by:

$$F_k = K|H_k|^2 f_k^2 d$$

where H_k is the transfer function for the given wire, f_k is the frequency for subcarrier k, d is the length of the wire and K is a constant.

7. A VDSL system, as claimed in either claim 5, or 6, characterised in that E_k is always less than a maximal allowable PSD-level, PSD_{max}, for said VDSL system.

8. A VDSL system, as claimed in claim 7, characterised in that:

$$E_k = \lambda \frac{n_k}{F_k} \qquad for \quad \lambda \frac{n_k}{F_k} < PSD_{max}$$

and

$$E_k = PSD_{max} \qquad for \quad \lambda \frac{n_k}{F_k} \geq PSD_{max}$$

9. A modem for use with a VDSL transmission system having a plurality of modems operating on an access network in which at least some of said modems operate on wires of different lengths, said modem having a target bit rate, characterised in that said modem has control means for reducing its transmit power so that FEXT produced by said modem is reduced.

10. A modem, as claimed in claim 9, characterised in that said control means is adapted to distribute power over an available frequency band so that said target bit rate is achieved.

11. A modem, as claimed in either claim 9, or 10, characterised in that said modem is adapted to modulate transmitted data using DMT.

12. A modem, as claimed in any of claims 9 to 11, characterised in that said modem is connected to a wire, and in that said control means is adapted to produce an energy loading for the k^{th} sub-carrier given by:

$$E_k = \lambda \frac{n_k}{F_k}$$

where n_k is the background noise on sub-carrier k, F_k is the FEXT transfer function for said wire and λ is a constant, λ being adjusted so that

$$R = \sum_{k=0}^{N-1} \log_2 \left(1 + \frac{E_k}{\Gamma(n_k + Fext_k)\Gamma_M}\right)$$

where $Fext_k$ is the FEXT from other VDSL modems, Γ is the SNR - gap, Γ_m is the system margin and R is the target bit rate per DMT frame.

13. A modem, as claimed in claim 12, characterised in that said FEXT transfer function is given by:

$$F_k = K|H_k|^2 f_k^2 d$$

where H_k is the transfer function for the given wire, f_k is the frequency for subcarrier k, d is the length of the wire and K is a constant.

14. A modem, as claimed in either claim 12, or 13, characterised in that E_k is always less than a maximal allowable PSD-level for VDSL.

15. A modem, as claimed in claim 14, characterised in that:

$$E_k = \lambda \frac{n_k}{F_k} \qquad for \quad \lambda \frac{n_k}{F_k} < PSD_{\max}$$

and

$$E_k = PSD_{\max} \qquad for \quad \lambda \frac{n_k}{F_k} \geq PSD_{\max}$$

16. In a VDSL transmission system having a plurality of modems operating on an access network in which at least some of said modems operate on wires of different lengths and in which there is a target bit rate for each modem, a method of performing power back-off, characterised by reducing the transmit power of modems on relatively short wires so that FEXT produced by said modems is reduced enabling modems on substantially longer wires to transmit at higher bit rates.

17. A method as claimed in claim 15, characterised by said relatively short wires being less than 1,000 metres long, and by said substantially longer wires being more than 1,000 metres long.

18. A method, as claimed in either claim 16, or claim 17, characterised by distributing power over an available frequency band so that said target bit rate is achieved.

19. A method, as claimed in any of claims 16, to 18, characterised by modulating transmitted data using DMT.

20. A method, as claimed in any of claims 15 to 19, characterised by producing an energy loading for the k[th] sub-carrier given by:

$$E_k = \lambda \frac{n_k}{F_k}$$

where n_k is the background noise on sub-carrier k, F_k is the FEXT transfer function for said given wire and λ is a constant which is adjusted so that

$$R = \sum_{k=0}^{N-1} \log_2 \left(1 + \frac{E_k}{\Gamma(n_k + Fext_k)\Gamma_M}\right)$$

where $Fext_k$ is the FEXT from other VDSL modems, Γ is the SNR - gap, Γ_m is the system margin and R is the target bit rate per DMT frame.

21. A method, as claimed in claim 20, characterised by said FEXT transfer function being given by:

$$F_k = K|H_k|^2 f_k^2 d$$

where H_k is the transfer function for the given wire, f_k is the frequency for sub-carrier k, d is the length of the wire and K is a constant.

22. A method, as claimed in either claim 20, or 21, characterised by E_k always being less than a maximal allowable PSD-level, PSD_{max}, for said VDSL system.

23. A method, as claimed in claim 22, characterised by:

$$E_k = \lambda \frac{n_k}{F_k} \qquad for \quad \lambda \frac{n_k}{F_k} < PSD_{\max}$$

and

$$E_k = PSD_{\max} \qquad for \quad \lambda \frac{n_k}{F_k} \geq PSD_{\max}$$

ABSTRACT

Improvements in, or Relating to, VDSL Transmission Systems

One problem, frequently encountered with VDSL transmission systems, is that upstream FEXT produced by system users having short wires can be very strong. Users having shorter wires get high bit rates whereas users having longer wires get low bit rates. In extreme cases it may happen that users with wire lengths greater than 1000 metre cannot transmit data upstream. The present invention provides a VDSL transmission system with a plurality of modems. The modems are located at varying distances from a central station. There is a target bit rate for each modem. That modems on shorter wires have control means for reducing their transmit power. This reduces the FEXT produced by these modems enabling modems on longer wires to transmit at higher bit rates.

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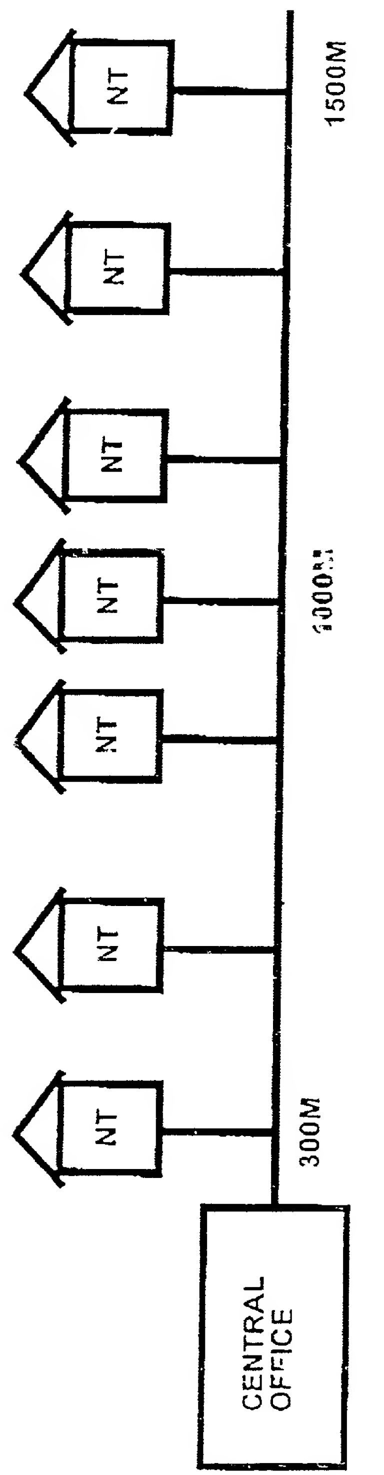
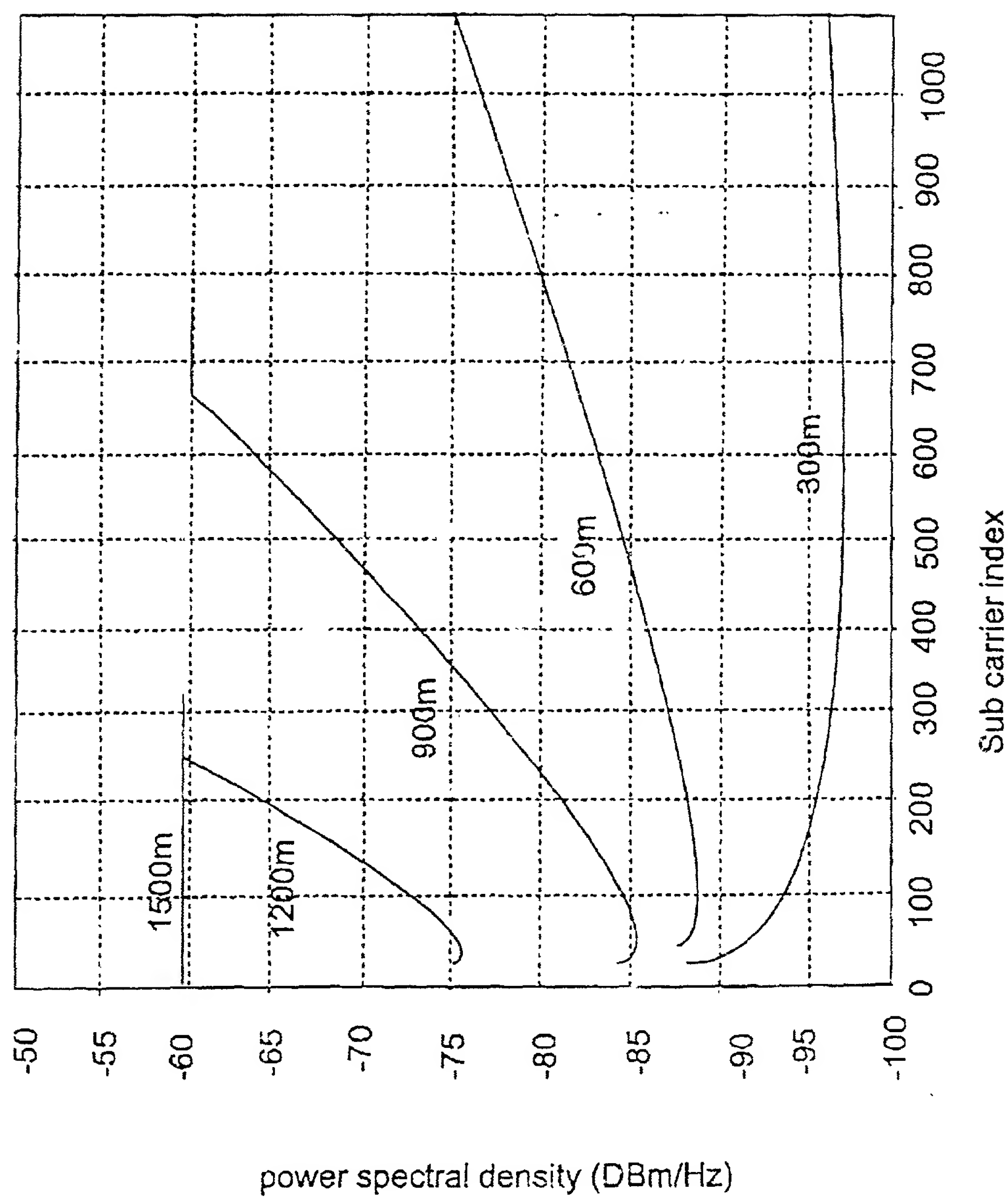


FIGURE 1



1500m
1200m
900m
600m
300m
-50
-55
-60
-65
-70
-75
-80
-85
-90
-95
-100
0
100
200
300
400
500
600
700
800
900
1000
Sub carrier index
power spectral density (DBm/Hz)

Fig 2

Declaration and Power of Attorney for Patent Application

Déclaration et Pouvoirs pour Demande de Brevet

French Language Declaration

En tant que l'inventeur nommé ci-après, je déclare par le présent acte que:

As a below named inventor, I hereby declare that:

Mon domicile, mon adresse postale, et ma nationalité sont ceux figurant ci-dessous à côté de mon nom.

My residence, post office address and citizenship are as stated next to my name.

Je crois être le premier inventeur original et unique (si un seul nom est mentionné ci-dessous), ou l'un des premiers co-inventeurs originaux (si plusieurs noms sont mentionnés ci-dessous) de l'objet revendiqué, pour lequel une demande de brevet a été déposée concernant l'invention intitulée:

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

IMPROVEMENTS IN, OR RELATING TO, VDSL TRANSMISSION SYSTEMS

IMPROVEMENTS IN, OR RELATING TO, VDSL TRANSMISSION SYSTEMS

et dont la description est fournie ci-joint à moins que la case suivante n'ait été cochée:

☐ a été déposée le sous le numéro de demande des Etats-Unis ou le numéro de demande international

☐ les specifications portant le dossier de l'avocat numero ____________________

et modifiée le ____________________ (le cas échéant).

the specification of which is attached hereto unless one of the following boxes is checked:

☐ was filed on as United States Application Number or International Number

☐ the specification of which bears attorney docket No. ____________________

and was amended on ____________________ (if applicable).

Je déclare par le présent acte avoir passé en revue et compris le contenu de la description ci-dessus, revendications comprises, telles que modifiées par toute modification dont il aura été fait référence ci-dessus.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

Je reconnais devoir divulguer toute information pertinente à la brevetabilité, comme défini dans le Titre 37, §1.56 du Code fédéral des réglementations.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

French Language Declaration

Je revendique par le présent acte avoir la priorité étrangère, en vertu du Titre 35, §119(a)-(d) ou § 365(b) du Code des Etats-Unis, sur toute demande étrangère de brevet ou certificat d'inventeur ou, en vertu du Titre 35, § 365(a) *du même Code*, sur toute demande internationale PCT désignant au moins un pays autre que les Etats-Unis et figurant ci-dessous et, en cochant la case, j'ai aussi indiqué ci-dessous toute demande étrangère de brevet, tout certificat d'inventeur ou toute demande internationale PCT ayant une date de dépôt précédant celle de la demande à propos de laquelle une priorité est revendiquée.

Prior foreign application(s)
Demande(s) de brevet antérieure(s)

PCT/SE99/02116	**PCT**	**18 NOVEMBER 1999**	☐
(Number) (Numéro)	(Country) (Pays)	(Day/Month/Year Filed) (Jour/Mois/Année de dépôt)	
9900788-2	**SWEDEN**	**5 MARCH 1999**	☐
(Number) (Numéro)	(Country) (Pays)	(Day/Month/Year Filed) (Jour/Mois/Année de dépôt)	
9804021-5	**SWEDEN**	**21 NOVEMBER 1998**	☐
(Number) (Numéro)	(Country) (Pays)	(Day/Month/Year Filed) (Jour/Mois/Année de dépôt)	

Priority not claimed
Droit de priorité non revendiqué

Je revendique par le présent acte tout bénéfice, en vertu du Titre 35 §119(e) du Code des Etats-Unis, de toute demande de brevet provisoire effectuée aux Etats-Unis et figurant ci-dessous.

(Application No.) (N° de demande) (Filing Date) (Date de dépôt)

(Application No.) (N° de demande) (Filing Date) (Date de dépôt)

Je revendique par le présent acte, le bénéfice, en vertu du Titre 35 § 120 du Code des Etats-Unis, de toute demande de brevet effectuée aux Etats-Unis, ou en vertu du Titre 35, § 365(c) du même Code, de toute demande internationale PCT désignant les Etats-Unis et figurant ci-dessous et, dans la mesure où l'objet de chacune des revendications de cette demande de brevet n'est pas divulgué dans la demande antérieure américaine ou internationale PCT, en vertu des dispositions du premier paragraphe du Titre 35, § 112 du Code des Etats-Unis, je reconnais devoir divulguer toute information pertinente à la brevetabilité, comme défini dans le Titre 37, § 1.56 du Code Fédéral des réglementations, dont j'ai pu disposer entre la date de dépôt de la demande antérieure et la date de dépôt de la demande nationale ou internationale PCT de la présente demande:

(Application No.) (N° de Demande) (Filing Date) (Date de Dépôt)

(Application No.) (N° de Demande) (Filing Date) (Date de Dépôt)

Je déclare par le présent acte que toute déclaration ci-incluse est, à ma connaissance, véridique et que toute déclaration formulée à partir de renseignements ou de suppositions est tenue pour véridique; et de plus, que toutes ces déclarations ont été formulées en sachant que toute fausse déclaration volontaire ou son équivalent est passible d'une amende ou d'une incarcération, ou des deux, en vertu de la Section 1001 du Titre 18 du Code des Etats-Unis, et que de telles déclarations volontairement fausses risquent de compromettre la validité de la demande de brevet ou du brevet délivré à partir de celle-ci.

I hereby claim foreign priority under Title 35, United States Code, §119(a)-(d) or § 365(b) of any foreign application(s) for patent or inventor's certificate, or § 365(a) of any PCT International application which designated at least one country other than the United States, listed below, and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed:

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below.

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) or § 365(c) of any PCT international application(s) designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application:

(Status)(Patented, pending abandoned)
(Statut)(breveté, en cours d'examen, abandonné)

(Status)(Patented, pending abandoned)
(Statut)(breveté, en cours d'examen, abandonné)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

French Language Declaration

POUVOIR: En tant que l'inventeur cité, je désigne par la présente l'(les) avocat(s) et/ou agent(s) suivant(s) pour qu'il(s) poursuive(nt) la procédure de cette demande de brevet et traite(nt) toute affaire s'y rapportant avec l'Office des brevets et des marques: *(mentionner le nom et le numéro d'enregistrement)*

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. *(list name and registration number)*

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Steven J. Henry	27,900	Douglas R. Wolf	36,971
Edward R. Gates	31,616	Elizabeth R. Plumer	36,637
Therese A. Hendricks	30,389	Timothy J. Oyer	36,628
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Ronald J. Kransdorf	20,004	Helen C. Lockhart	39,248
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Jason M. Honeyman	31,624	Christopher S. Schultz	39,039
James H. Morris	34,681		

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Robert M. Abrahamsen	37,482	Robert H. Walat	46,324
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Edward J. Russavage	43,069	Michael J. Pomianek	46,190
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French Language Declaration	
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Nationalité	Citizenship **Swedish**
Adresse Postale	Post Office Address **Forskarvägen 36 A**
Nom complet du second co-inventeur, le cas échéant 500	Full name of second or joint inventor **ISAKSSON Mikael**
Signature de l'inventeur Date	Inventor's signature Date Mikael Isaksson 2000-10-02
Domicile	Residence **S-973 42 LULEÅ, SWEDEN** SEX
Nationalité	Citizenship **Swedish**
Adresse Postale	Post Office Address **Borgmästarevägen 7**

French Language Declaration

Nom complet de l'unique ou premier inventeur 600	Full name of sole or first inventor **NORDSTRÖM Tomas**
Signature de l'inventeur Date	Inventor's signature Date 2000-10-11
Domicile	Residence **S-977 53 LULEÅ, SWEDEN** SEX
Nationalité	Citizenship **Swedish**
Adresse Postale	Post Office Address **Prästgårdsvägen 3**
Nom complet du second co-inventeur, le cas échéant 700	Full name of second or joint inventor **ÖDLING Per**
Signature de l'inventeur Date	Inventor's signature Date 2000-10-09
Domicile	Residence **S-977 51 LULEÅ, SWEDEN** SEX
Nationalité	Citizenship **Swedish**
Adresse Postale	Post Office Address **Professorsvägen 109 B**
Nom complet du second co-inventeur, le cas échéant 800	Full name of second or joint inventor **BAHLENBERG Gunnar**
Signature de l'inventeur Date	Inventor's signature Date 2000-10-02
Domicile	Residence **S-976 32 LULEÅ, SWEDEN** SEX
Nationalité	Citizenship **Swedish**
Adresse Postale	Post Office Address **Blidvägen 234**

French Language Declaration	
Nom complet du second co-inventeur, le cas échéant 900	Full name of second or joint inventor **JOHANSSON Magnus**
Signature de l'inventeur Date	Inventor's signature Date 2000-10-02
Domicile	Residence **S-972 41 LULEÅ, SWEDEN** SE4
Nationalité	Citizenship **Swedish**
Adresse Postale	Post Office Address Timmermansgatan 34
Nom complet du second co-inventeur, le cas échéant 1000	Full name of second or joint inventor **OLSSON Lennart**
Signature de l'inventeur Date	Inventor's signature Date 2000-10-02
Domicile	Residence S-973 31 LULEÅ, SWEDEN SE4
Nationalité	Citizenship Swedish
Adresse Postale	Post Office Address Majvägen 39
Nom complet du second co-inventeur, le cas échéant 1100	Full name of second or joint inventor **ÖKVIST Sven-Göran**
Signature de l'inventeur Date	Inventor's signature Date 2000-10-02
Domicile	Residence **S-974 41 LULEÅ, SWEDEN** SEX
Nationalité	Citizenship Swedish
Adresse Postale	Post Office Address **Hagaplan 7**